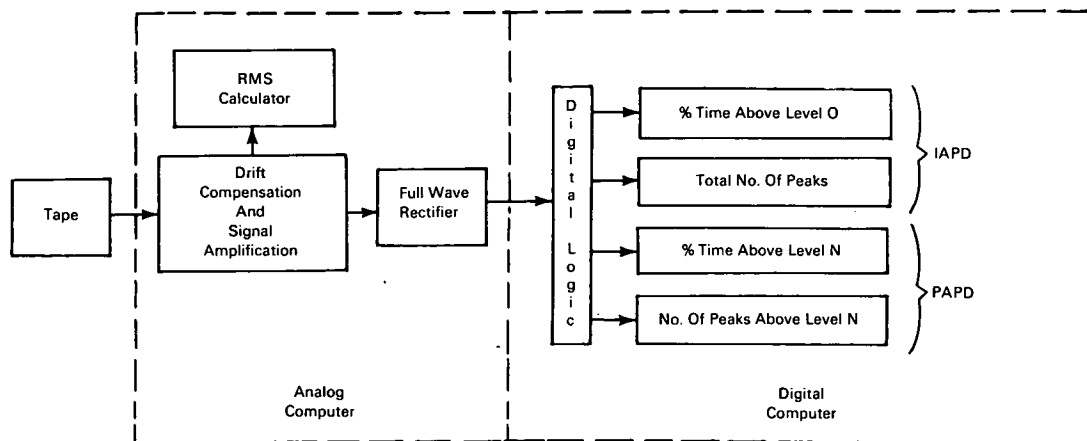


NASA TECH BRIEF



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Hybrid Computer Technique Yields Random Signal Probability Distributions



The problem: A complete space vehicle responds, during launch, to a variety of loadings, the study of which requires the outputs of many sensors. Analyzing these data graphically by hand introduces delays and human error factors. A rapid, accurate determination of probability distributions from the sensor outputs is needed.

The solution: A special digital logic computer is combined with a standard analog computer to determine the probability distributions of both the instantaneous and peak amplitudes of a random signal recorded on magnetic tape.

How it's done: The instantaneous amplitude probability distribution (IAPD) of a random signal is the percentage of time the signal is above some arbitrary value, where there are n arbitrary values to provide the distribution comparison. The peak amplitude probability distribution (PAPD) of a random signal is the percentage of the total number of peaks that are

above some arbitrary value where there are n arbitrary values.

The recorded signal from the tape is amplified and fed to a low pass filter, whose output is inverted and subtracted from the input signal to remove the low frequency components identified with drift in the sensing and recording devices. The RMS calculator continuously generates the root-mean-square of this information signal. The RMS signal is rectified and routed to the digital logic where the two components (IAPD and PAPD) are determined and fed to the readout. To measure the percentage of time the signal is above some arbitrary value (IAPD), it is assumed that the signal exceeded that level 100% of the time, and the amount of time the signal was below that level is subtracted. This is accomplished by dividing the logic time base into 10,000 equal increments and subtracting one digit for each time increment the signal is below that level. When the time base counter reaches

(continued overleaf)

0000, it produces a carryout that stops the computer and feeds the answer to the readout.

To measure the percentage of the total number of peaks that are above some arbitrary value (PAPD), comparator outputs drive one-way digital differentiators. A one-way differentiator produces a blip one clock pulse wide when the input goes from the low level to the high level (goes from 0 to 1). The differentiator output drives a binary upcounter. When the input to the counter is high, it will count up one bit at each clock pulse. Since the differentiator is high for only one clock pulse, the counter will add one bit each time the increasing signal crosses the set level. The signal, rather than the absolute value, drives the counter in level 0. This assures that the signal will pass through zero. The counter in level 0 counts only half the total peaks because the negative portion of the signal has no effect on the comparator.

Notes:

1. Data that requires five to seven man-days to reduce by hand can be reduced in 30 seconds by this method.
2. This method of analysis should have application in such nonstationary random processes as system characteristics in structural, electrical, atomic energy, or biomedical fields.
3. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California, 94035
Reference: B65-10208

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

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(ARC-34)